

<b>ENGINEERING CALCULATIONS</b>	<b>Manual</b>	<b>Engineering</b>
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[Ownership matrix](#)

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## 1.0 PURPOSE AND SCOPE

(7.1.2)

This procedure describes the process for preparing, processing, and revising WRPS engineering calculations. It also describes the process used by WRPS to accept calculations completed by outside contractors and suppliers. This process applies to all engineering, design, process, or nuclear safety calculations prepared as engineering deliverables or as a part of another deliverable.

Calculations prepared solely using spreadsheets shall follow [TFC-ENG-DESIGN-C-32](#). If the calculation involves a combination of spreadsheet and hand calculations or other software, then the requirements of this procedure and [TFC-ENG-DESIGN-C-32](#) shall be met.

The following types of calculations are exempted from the requirements of this procedure:

- Simple calculations that meet the definition of a computation as defined in Section 5.0
- Calculations that are performed to check or verify another calculation, software, or spreadsheet
- Business, financial, or non-technical calculations.

This procedure is implemented by WRPS Engineering, Radiological Control, Environmental, Nuclear Safety, and Project Integration.

## 2.0 IMPLEMENTATION

This procedure is effective on the date shown in the header.

## 3.0 RESPONSIBILITIES

Responsibilities are contained within Section 4.0.

## 4.0 PROCEDURE

See [Figure 1](#) for process flow diagram.

### 4.1 Determine Category of Calculation

Organizational  
Manager

1. For WRPS calculations, use the criteria in [Table 1](#) to determine the category of calculations to be prepared by the organization. (See Table 2 for a list of typical calculation types and associated categories.)

NOTE 1: Calculations are categorized as either formal (Section 4.2), informal (Section 4.3), or computation (Section 5.0) based on the potential impacts of an incorrect calculation. For both formal and informal calculations, Section 4.4 addresses computer software; Section 4.4.1, use of MathCad\*, Section 4.4.2 use of Microsoft Excel; and Section 4.4.3, calculations contained in other technical documents.

NOTE 2: If the use of Table 1 results in categorization as “computation,” then there are no further procedural requirements.

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\*MathCad is a registered trademark of Mathsoft Engineering and Education, Inc., Cambridge, MA.

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## 4.2 Formal Calculations

### 4.2.1 Preparation, Review, and Approval

Formally release the calculation as an engineering document into the Hanford Document Control System (see [TFC-ENG-DESIGN-C-25](#)) or as part of another engineering document.

Organizational  
Manager

1. Assign a qualified engineer or analyst to prepare the calculation and communicate the expected category of calculation as determined in Section 4.1.

2. Assign a qualified checker to review the calculation.

Engineer/Analyst

3. Prepare the calculation:

- a. Format the body of the calculation following the criteria given in Attachment A. Other sections may be added and the exact order of the sections is left to the engineer/analyst.

NOTE: Where calculations are prepared in support of documents that have their own procedural requirements and format, the document-specific format requirements take precedence over the format requirements of this procedure, e.g., waste compatibility assessments ([TFC-ENG-CHEM-P-13](#)).

- b. Assign a unique title and obtain a document number from Hanford Document Numbering System ([HDNS](#)). To aid in retrievability, include key words that relate the calculation to the system, structure, component, area, project, or analogous terms.
- c. Prepare the calculation in a legible form suitable for reproduction, filing, and retrieval using the header shown in [Figure 2](#) for each page. Documentation of electronically generated calculation sheets (such as MathCad) is to use a format containing the same information as Figure 2.
- d. Provide the page number, the unique title, document number, and the revision number on each page of the calculation and on all attachment pages.
- e. Ensure that the calculation is prepared such that a technically qualified, independent person (e.g., checker) can repeat the calculation and come to the same conclusion without recourse to the engineer/analyst.
- f. Ensure that the results of the calculations are assessed for impacts on requirements and that appropriate changes to requirements in the affected requirements documents (e.g., system/subsystem specifications and Operating Specification Documents) are initiated in accordance with [TFC-ENG-DESIGN-C-06](#).

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- |                              |   |
|------------------------------|---|
|                              | 4. Forward hard or electronic copy (check copy) of the calculation to the assigned checker, along with any documents that directly affect the calculation, such as drawings, codes, standards, and related analyses.  |
| Checker                      | <p>5. Verify the calculation is technically accurate, suitable for the intended use, and compliant with this procedure, using Figure 3 as a checklist for key attributes. Verification of design calculations may be performed by alternate calculations. The alternate calculation is the check of the calculation and shall be attached to the calculation.</p> <p>6. Review each page of the check copy of the calculation highlighting either on the hard copy or electronically any comments or changes required.</p> <p>7. Return the marked check copy of the calculation to the engineer/analyst.</p> |
| Engineer/Analyst             | <p>8. Resolve comments with the checker.</p> <p>a. Make the agreed upon corrections.</p> <p>b. Make a copy of the corrected calculation for the checker for back checking (if requested by the checker).</p> <p>9. For electronic calculations, once all comments have been resolved to the satisfaction of the checker, print a final copy of the calculation for signature.</p>   |
| Engineer/Analyst and Checker | <p>10. Sign and date, initial and date, or print name and date on each page of the calculation and complete the formal calculation review checklist (<a href="#">Figure 3</a>) to signify that the resolution of review comments is complete and that the calculation complies with this procedure. Include the completed review checklist as a part of the calculation. Additional organization-specific review checklists may be included also.</p>   |

NOTE 1: For computer printout data (input or output files), complete Figure 2 as the cover sheet of the computer printout. Signature or name on subsequent pages of computer printout is not required. Pages that contain textual information but not actual calculations do not need signature or name. For example, when the numerical calculations are contained in an appendix and the objectives and method are contained in the main body of the document, only the pages of the appendix containing the calculations have signatures or names.

NOTE 2: Where calculations are prepared in support of documents that have their own procedural preparation and review requirements, a document-specific review checklist may be substituted for the formal calculation review checklist provided in Figure 3. If no checklist is provided in the document-specific procedure, the checklist provided in this procedure shall be used.

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Engineer/Analyst      11. Prepare and sign an Engineering Data Transmittal (EDT) in accordance with [TFC-ENG-DESIGN-C-25](#).

Checker      12. In situations where the design configuration depends on a calculation, ensure applicable design documents (e.g., drawings, ECNs, specifications) are consistent with the calculation.

Organizational Manager      13. Review the calculation for compliance with procedural requirements and ensure that it is suitable for its intended use; sign the EDT form signifying that the engineer/analyst and checker are both qualified, the review was satisfactory, and that correct approval designators are used in accordance with [TFC-ENG-DESIGN-C-25](#).

NOTE: For formal calculations, the engineer/analyst, checker, and organizational manager must be different individuals.

Engineer/Analyst      14. After all required review signatures are obtained, submit the EDT form containing the calculation to a Document Control Services Center in accordance with applicable procedures.

NOTE: Check copy does not have to be retained after calculation issue.

#### 4.2.2 Revision of Approved Formal Calculations

Engineer/Analyst      1. If an inadequacy or error is found in a calculation and the calculation is part of the design basis (referenced in a system design description that has been issued), notify the affected system engineer and initiate a Problem Evaluation Request (PER) in accordance with [TFC-ESHQ-Q C-C-01](#).

2. If a revision is required such as update to the analysis, changes in assumptions, new data, resolve inadequacies or errors, or to close an engineering HOLD or TBD (see [TFC-ENG-DESIGN-C-25](#)), prepare a revision to the calculation by:

a. Correcting pages of the calculation to correct any erroneous, misleading, or unclear information.

b. For minor revisions, identifying such corrections within the calculation with a change bar in the right margin adjacent to the revised material.

c. For major revisions, changing the revision number or letter for the page to the new revision identifier for the calculation.

d. Updating change documentation as required by [TFC-ENG-DESIGN-C-25](#), and [TFC-ENG-DESIGN-C-06](#).

Engineer/Analyst/  
Checker      3. Complete Section 4.2.1, steps 4 through 12.

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Organizational Manager 4. Complete Section 4.2.1, step 13.

Engineer/Analyst 5. Complete Section 4.2.1, step 14.

#### 4.2.3 Formal Calculations by Subcontractors

Calculations prepared by outside contractors or suppliers for WRPS (non-shared resource) are prepared according to the quality assurance requirements identified in the procurement specification or subcontract and these calculations must be accepted by WRPS. Acceptance by WRPS is in addition to the subcontractor's quality assurance requirements. Calculations prepared by contractors or suppliers may be in a format similar to those prepared by WRPS or may be embedded in a technical document or issued as a letter report. If the calculation is embedded in a technical document or issued as a letter report, it is especially important to ensure that relevant design assumptions and inputs are clearly identified and that the document is reviewed for acceptability in the same manner as if it were issued as a separate calculation. Acceptance of the calculations is required prior to relying on the results of the calculation or using an item that the calculations support. Calculations prepared for other projects that apply to the new design may be used instead of developing new calculations.

Organizational Manager 1. Assign an engineer/analyst to review the calculation for release as a supporting document or directly into the Hanford Document Control System (HDCS) using an EDT (see [TFC-ENG-DESIGN-C-25](#)).

Engineer/Analyst 2. Review the calculation to ensure applicability (consistent with the item the calculation supports), concurrence with assumptions and inputs, and reasonableness of results and conclusions; if discrepancies are discovered, return the calculation for rework before completing the review.

3. Prepare [Figure 4](#) and sign it as reviewer indicating that the review was satisfactory.

Organizational Manager 4. Review the calculation for suitability for its intended use and sign Figure 4 signifying that the engineer/analyst was qualified and that the calculation meets these requirements.

Engineer/Analyst 5. Obtain any additional signatures and process in accordance with [TFC-ENG-DESIGN-C-25](#), or into the HDCS using an EDT ([TFC-ENG-DESIGN-C-25](#)).

#### 4.3 Informal Calculations

The following sections represent the minimum requirements for informal calculations. The organizational manager may add calculation and release requirements to more closely resemble formal calculations.

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#### 4.3.1 Preparation, Review, and Approval

The calculation will usually be released as an electronic information file ([TFC-ENG-DESIGN-D-27](#)) or as an attachment to an ECN ([TFC-ENG-DESIGN-C-06](#)).

Organizational  
Manager

1. Assign a qualified engineer/analyst to prepare the calculation
2. Assign a qualified checker to review the calculation.

Engineer/Analyst

3. Prepare the calculation:
  - a. Format the body of the calculation following the criteria given in Attachment A. Other sections may be added and the exact order of the sections is left to the engineer/analyst.

NOTE: Where calculations are prepared in support of documents that have their own procedural requirements and format, the document-specific format requirements take precedence over the format requirements of this procedure, e.g., Waste Compatibility Assessments ([TFC-ENG-CHEM-P-13](#)).

- b. Assign a unique title, and for release as an electronic information file (EIF), assign a unique title and identifier in accordance with [TFC-ENG-DESIGN-D-27](#). To aid in retrievability, include key words that relate the calculation to the system, structure, component, area, project, or analogous terms.
  - c. Produce the calculation in a legible form suitable for reproduction, filing, and retrieval using the header shown in Figure 2 for each page. Documentation of electronically-generated calculation sheets (such as MathCad) are to use a format that contains the same information as Figure 2.
  - d. Provide the page number, the unique title and identifier, and the revision number on each page of the calculation and on all attachment pages.
4. Ensure that the calculation is prepared such that a technically qualified, independent person (e.g., checker) can repeat the calculation and come to the same conclusion without recourse to the engineer/analyst.
5. Ensure that the results of the calculations are assessed for impacts on requirements and that appropriate changes to requirements in the affected requirements documents (e.g., system/subsystem specifications and Operating Specification Documents) are initiated in accordance with [TFC-ENG-DESIGN-C-06](#).

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- |                              |   |
|------------------------------|---|
| Engineer/Analyst             | 6. Forward hard or electronic copy of the check copy of the calculation to the assigned checker along with any documents that directly affect the calculation, such as drawings, codes, standards, and related analyses.  |
| Checker                      | <p>7. Verify the calculation is technically accurate, suitable for the intended use, and compliant with this procedure using <a href="#">Figure 3</a> as a checklist for key attributes. Verification of design calculations may be performed by alternate calculations. The alternate calculation is the check of the calculation and shall be attached to the calculation.</p> <p>8. Review each page of the check copy of the calculation highlighting either on the hard copy or electronically any comments or changes required.</p> <p>9. Return the copy of the calculation with any comments noted to the engineer/analyst.</p> |
| Engineer/Analyst             | <p>10. Resolve comments with the checker.</p> <p style="margin-left: 40px;">a. Make the agreed upon corrections.</p> <p style="margin-left: 40px;">b. Make a copy of the corrected calculation for the checker for back checking (if requested by the checker).</p> <p>11. For electronic calculations, once all comments have been resolved to the satisfaction of the checker, print a final copy of the calculation for signature.</p>   |
| Engineer/Analyst and Checker | 12. Sign and date, initial and date, or print name and date on each page of the calculation and complete the calculation review checklist ( <a href="#">Figure 3</a> ) to signify that the resolution of review comments is complete and that the calculation complies with this procedure. Include the completed review checklist as a part of the calculation. Additional organization-specific review checklists may be included also.   |

NOTE 1: For computer printout data (input or output files), complete [Figure 2](#) as the cover sheet of the computer printout. Signature or name on subsequent pages of computer printout is not required. Pages that contain textual information but not actual calculations do not need signature or name. For example, when the numerical calculations are contained in an appendix and the objectives and method are contained in the main body of the document, only the pages of the appendix containing the calculations have signatures or names.

NOTE 2: Where calculations are prepared in support of documents that have their own procedural preparation and review requirements, a document specific review checklist may be substituted for the formal calculation review checklist provided in [Figure 3](#). If no checklist is provided in the document-specific procedure, the checklist provided in this procedure shall be used.

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- |                        |   |
|------------------------|---|
| Engineer/Analyst       | 13. Prepare an EIF in accordance with <a href="#">TFC-ENG-DESIGN-D-27</a> or an ECN form in accordance <a href="#">TFC-ENG-DESIGN-C-06</a> .  |
| Checker                | 14. In situations where the design configuration is dependent on a calculation, ensure applicable design documents (e.g., drawings, ECNs) are consistent with the calculation.  |
| Organizational Manager | 15. Review the calculation for compliance with procedural requirements and that it is suitable for its intended use. <div style="margin-left: 20px;">           a. For calculations issued into an EIF, sign the header on Page 1 of the calculation or<br/>           b. For calculations issued with an ECN, sign the ECN form signifying that the engineer/analyst and checker are both qualified, the review was satisfactory, and that correct approval designators are used.         </div> |

NOTE: For informal calculations, there must be at least two qualified persons completing the functions of engineer/analyst, checker, and organizational manager. Since the organizational manager will be the approver, the organizational manager may also be either the engineer/analyst or the checker, but not both.

- |                  |   |
|------------------|---|
| Engineer/Analyst | 16. After all required review signatures have been obtained; forward the ECN form or EIF package containing the calculation to Records Information Management in accordance with <a href="#">TFC-ENG-DESIGN-C-06</a> or <a href="#">TFC-ENG-DESIGN-D-27</a> , respectively. |
|------------------|---|

NOTE: Check print does not have to be retained after calculation issue.

#### 4.3.2 Revision of Approved Informal Calculations

- |                  |  |
|------------------|--|
| Engineer/Analyst | 1. If a revision is required such as update to the analysis, changes in assumptions, new data, resolve inadequacies or errors, or to close an engineering HOLD or TBD, prepare a revision to the calculation by: <ul style="list-style-type: none"> <li>• Correcting all pages of the calculation to correct any erroneous, misleading, or unclear information.</li> <li>• For minor revisions, identifying such corrections within the calculation with a change bar in the right margin adjacent to the revised material.</li> <li>• For major revisions, changing the revision number or letter for the page to the new revision identifier for the calculation.</li> <li>• Updating change documentation as required by <a href="#">TFC-ENG-DESIGN-C-06</a> or <a href="#">TFC-ENG-DESIGN-D-27</a>.</li> </ul> |
|------------------|--|

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Engineer/Analyst/Checker 2. Complete Section 4.3.1, steps 4 through 14.

Organizational Manager 3. Complete Section 4.3.1, step 15.

Engineer/Analyst 4. Complete Section 4.3.1, step 16.

#### 4.3.3 Informal Calculations by Subcontractors

Calculations prepared by outside contractors or suppliers for WRPS (non-shared resource) are prepared according to the quality assurance requirements identified in the procurement specification or subcontract and these calculations must be accepted by WRPS. Acceptance by WRPS is in addition to the subcontractor's quality assurance requirements. Calculations prepared by contractors or suppliers may be in a format similar to those prepared by WRPS or may be embedded in a technical document or issued as a letter report. If the calculation is embedded in a technical document or issued as a letter report, it is especially important to ensure that relevant design assumptions and inputs are clearly identified and that the document is reviewed for acceptability in the same manner as if it were issued as a separate calculation. Acceptance of the calculations is required prior to relying on the results of the calculation or using an item that the calculations support. Calculations prepared for other projects that apply to the new design may be used instead of developing new calculations.

Organizational Manager 1. Assign an engineer/analyst to review the calculation for release as an EIF or into the HDCS.

Engineer/Analyst 2. Review the calculation to ensure applicability (agreement with the item the calculation supports), concurrence with assumptions and inputs, and reasonableness of results and conclusions; if discrepancies are discovered, return the calculation for rework before completing the review.

3. Prepare [Figure 4](#) and sign it as reviewer indicating that the review was satisfactory.

Organizational Manager 4. Review the calculation for suitability for its intended use and sign Figure 4 signifying that the engineer/analyst was qualified and that the calculation meets these requirements.

Engineer/Analyst 5. Obtain any additional signatures and process in accordance with [TFC-ENG-DESIGN-D-27](#) or using an EDT in accordance with [TFC-ENG-DESIGN-C-25](#).

#### 4.4 Computer Software (7.1.1)

Custom software or commercial off-the-shelf software (COTS) must meet the requirements of [TFC-BSM-IRM\\_HS-C-01](#) prior to their use in engineering calculations.

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#### 4.4.1 Calculations Using MathCad

Calculations that use MathCad software must use the version available from HLAN. The calculation, including the portion generated by MathCad, is prepared and checked by following the sections of this procedure that pertain to the category of the calculation.

#### 4.4.2 Calculations Using Excel

Calculations containing Excel spreadsheets must use the version available from HLAN.

- |                              |   |
|------------------------------|---|
| Engineer/Analyst             | 1. Calculations performed solely using Excel are prepared in accordance with <a href="#">TFC-ENG-DESIGN-C-32</a> . If the calculation involves hand calculations or uses software other than Excel, it must meet the requirements of this procedure and <a href="#">TFC-ENG-DESIGN-C-32</a> . |
| Engineer/Analyst/<br>Checker | 2. Complete and document verification of spreadsheet portion of calculation in accordance with <a href="#">TFC-ENG-DESIGN-C-32</a> .  |
|                              | 3. If the spreadsheet calculation requires documenting in accordance with this procedure, complete review process for the calculation as a whole using the sections of this procedure that pertain to the category of the calculation.  |

#### 4.4.3 Calculations in other Technical Documents

This section identifies how to handle calculations included in technical documents whose main purpose is not to perform the calculation itself. Such documents are prepared for many purposes, including interpretation of calculation results, use of calculation results to make programmatic decisions, to support design descriptions, to support operational decisions, to support the safety basis documents and decisions, or to support environmental permitting documents and decisions. It is especially important for authors and reviewers of technical documents to recognize when the document contains calculations and to ensure that the calculations meet the requirements of this procedure.

Calculations may be presented in text documents in one of three ways:

- Embedded in the main body of a document
- Included as an appendix to a document
- Prepared as separate document and included as a reference in the primary document.

The choice of how to present the calculation is based on consideration of the complexity of the calculation and the need for the reader to be able to view the calculation details within the primary document. The following table should be used as a guide in selecting the appropriate method of presentation for the calculation.

Reader Needs to View Calculation Details	Criteria	Method of Calculation Presentation
Yes	<ul style="list-style-type: none"> <li>• Calculation is simple and easily performed.</li> <li>• Calculation has limited input data.</li> <li>• Calculation and results can be presented in two pages or less.</li> <li>• Presentation in main body does not detract from main purpose of document.</li> </ul>	Embedded
Yes	<ul style="list-style-type: none"> <li>• Calculation is complex and more difficult to perform.</li> <li>• Calculation contains extensive input data.</li> <li>• Calculation is lengthy.</li> </ul>	Include as appendix
Yes	<ul style="list-style-type: none"> <li>• Calculation meets criteria for embedded but inclusion in main body detracts from main purpose of document.</li> </ul>	Include as appendix
No	<ul style="list-style-type: none"> <li>• Calculation meets criteria for embedded but it is desired not to prepare as a separate document.</li> </ul>	Include as appendix
No	<ul style="list-style-type: none"> <li>• Calculation is complex and more difficult to perform.</li> <li>• Calculation contains extensive input data.</li> <li>• Calculation is lengthy.</li> </ul>	Prepare as separate document and include as reference
No	<ul style="list-style-type: none"> <li>• Calculation may be referenced in other documents.</li> </ul>	Prepare as separate document and include as reference

## 5.0 DEFINITIONS

Alternate calculations. A method of verifying the correctness of original calculations or analyses by using alternate methods to perform an equivalent calculation. In performing an alternate calculation, the appropriateness of assumptions, input data, and computer hardware/software, if used, is also evaluated.

Computation. A computation is a simple calculation in which:

- Simple arithmetic is used
- Assumptions are not critical to the results
- A permanent record is not needed (i.e., it does not need to be referenced and can easily be reconstructed)
- Special engineering expertise is not needed.
- Engineering expertise is used to evaluate the problem, and a formal calculation is not required.

Examples of computations include length of a zip cord, areas and volumes, simple thermal expansion, and simple unit conversions. There are no procedural requirements for simple computations.

## 6.0 RECORDS

The following records are generated during the performance of this procedure:

Record Description	Vital Record Y/N	QA Record Y/N	QA Record Retention L/NP	NARA Retention Schedule	Other Retention Requirements	Records Custodian
Formal calculation packages	N	Y	NP	ADM-17.31a1	N/A	IRM Service Provider

The identified record custodian is responsible for record retention in accordance with [TFC-BSM-IRM DC-C-02](#).

## 7.0 SOURCES

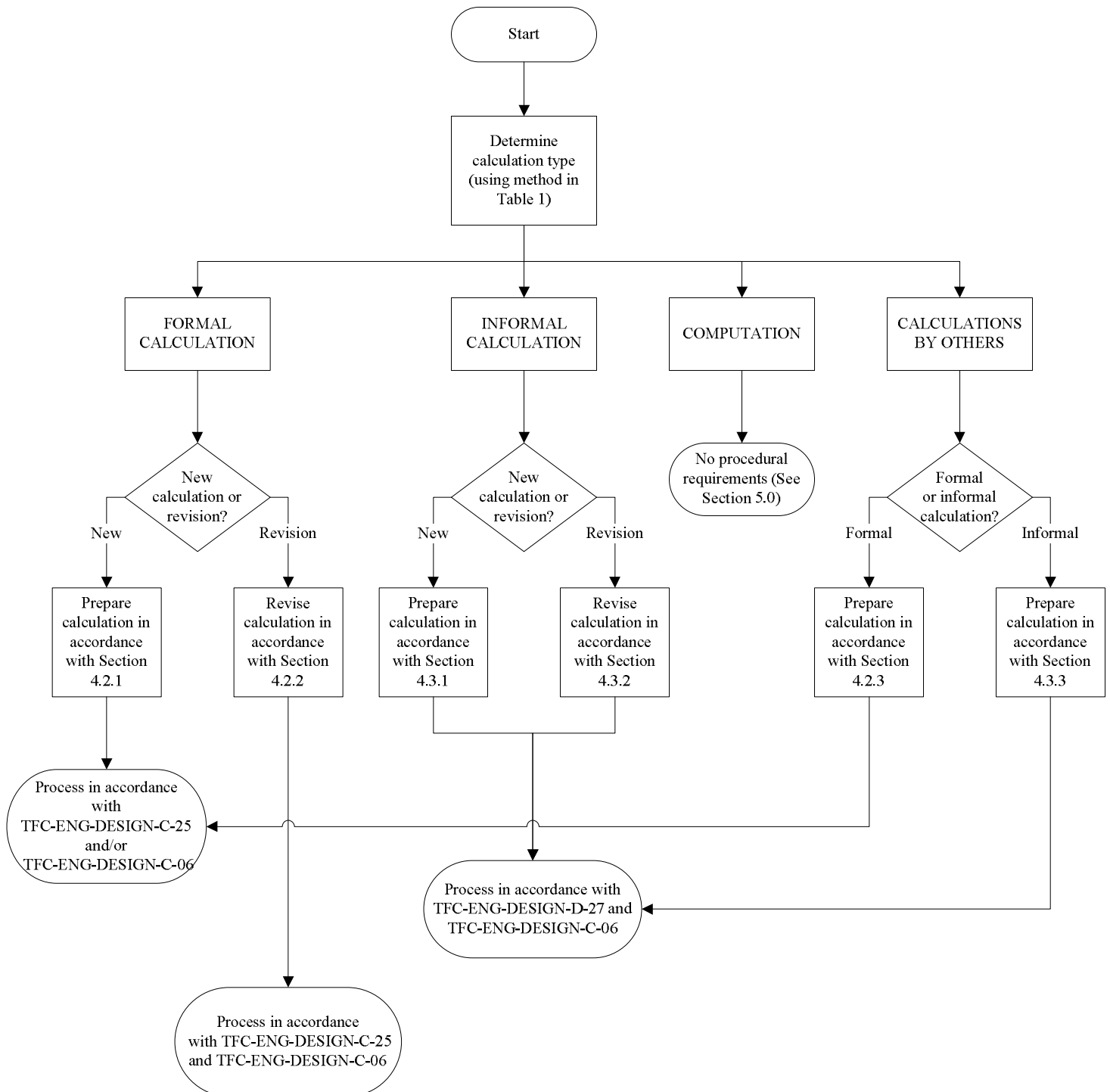
### 7.1 Requirements

1. TFC-BSM-IRM\_HS-C-01, "Software Development, Implementation, and Management."
2. TFC-PLN-02, "Quality Assurance Program Description."

### 7.2 References

1. TFC-BSM-IRM\_DC-C-02, "Records Management."
2. TFC-ENG-CHEM-P-13, "Tank Waste Compatibility Assessments."
3. TFC-ENG-DESIGN-C-06, "Engineering Change Control."
4. TFC-ENG-DESIGN-C-25, "Technical Document Control."
5. TFC-ENG-DESIGN-C-32, "Spreadsheet Development and Verification."
6. TFC-ENG-DESIGN-D-27, "Electronic Information File."
7. TFC-ENG-DESIGN-P-17, "Design Verification."
8. TFC-ESHQ-Q\_C-C-01, "Problem Evaluation Request."

Figure 1. Calculation Process.



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**Figure 2. Calculation Page Header.**

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**Title:** Include a descriptive title for the calculation

**Originator:** Print **Date:** \_\_\_\_\_

**Checker:** Print **Date:** \_\_\_\_\_

**Organizational Manager:** Print and Sign (see note below) **Date:** \_\_\_\_\_

The header of each page of the calculation contains, as a minimum, the information shown above. Attachment A provides details on calculation format.

**NOTE:** The signature line for organizational manager is not required for formal calculations or for informal calculations that are part of an ECN. The signature line for organizational manager is required only on Page 1 of informal calculations that are issued into an EIF in accordance with TFC-ENG-DESIGN-D-27.

**Figure 3. Calculation Review Checklist.**

Calculation Reviewed: \_\_\_\_\_

Scope of Review: \_\_\_\_\_  
(e.g., document section or portion of calculation)

Engineer/Analyst: \_\_\_\_\_ Date: \_\_\_\_\_

Organizational Manager: \_\_\_\_\_ Date: \_\_\_\_\_

This document consists of \_\_\_\_\_ pages and the following attachments (if applicable):

Yes	No	NA*	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1. Analytical and technical approaches and results are reasonable and appropriate.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	2. Necessary assumptions are reasonable, explicitly stated, and supported.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	3. Ensure calculations that use software include a paper printout, microfiche, CD-ROM, or other electronic file of the input data and identification to the computer codes and versions used, or provide alternate documentation to uniquely and clearly identify the exact coding and execution process.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	4. Input data were checked for consistency with original source information.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5. Key input data (e.g., dimensions, performance characteristics) that may affect equipment design is identified.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	6. For both qualitative and quantitative data, uncertainties are recognized and discussed and the data is presented in a manner to minimize design interpretations.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	7. Mathematical derivations were checked, including dimensional consistency of results.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	8. Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	9. Software verification and validation are addressed adequately.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10. Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	11. Conclusions are consistent with analytical results and applicable limits.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	12. Results and conclusions address all points in the purpose.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	13. Referenced documents are retrievable or otherwise available.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	14. The version or revision of each reference is cited.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	15. The document was prepared in accordance with Attachment A, "Calculation Format and Preparation Instructions."
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	16. Impacts on requirements have been assessed and change documentation initiated to incorporate revisions to affected documents, as appropriate.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	17. All checker comments have been dispositioned and the design media matches the calculations.

\_\_\_\_\_  
Checker (printed name and signature)

\_\_\_\_\_  
Date

\* If No or NA is chosen, an explanation must be provided on or attached to this form.

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**Figure 4. Subcontractor Calculation Review Checklist.**

Page \_\_\_\_ of \_\_\_\_

**Subject:** \_\_\_\_\_

**The subject document has been reviewed by the undersigned.  
The reviewer reviewed and verified the following items as applicable.**

Documents Reviewed: \_\_\_\_\_

Analysis Performed By: \_\_\_\_\_

- Design Input
- Basic Assumptions
- Approach/Design Methodology
- Consistency with item or document supported by the calculation
- Conclusion/Results Interpretation
- Impact on existing requirements
- \_\_\_\_\_

Reviewer (printed name, signature, and date)\_\_\_\_\_

Organizational Manager (printed name, signature and date)\_\_\_\_\_

**Table 1. Determination of Calculation Category.**

Use the following table to determine the minimum calculation category based upon risk criteria and importance factors.

NOTE: At a manager's discretion, any calculation category can be raised to a higher category but cannot be lowered.

<b>Risk Criteria</b>	<b>Importance Factor *</b>	<b>Minimum Calculation Category</b>
Nuclear Safety classification of item supported by calculation	SC	Formal
	SS	Formal
	≤ GS	Formal, Informal or Computation (continue using following criteria)
Impact of incorrect calculation on program or operation of facility or project	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)
Impact of incorrect calculation on facility or worker safety	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)
Impact of incorrect calculation on environment and related regulations	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)
Impact of incorrect calculation on radiological safety	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)
Impact of incorrect calculation on potential for adverse client and/or stakeholder impacts and reporting	H	Formal
	M	Formal or Informal (Manager Decision)
	L	Informal or Computation (Manager Decision)

**\* Legend:**

- GS = General Service
- SC = Safety Class
- SS = Safety Significant
- H = Critical Impact (could directly cause failure to meet risk criteria)
- M = Significant Impact (could have major influence on ability to meet risk criteria)
- L = Minor Impact (little or no influence on ability to meet risk criteria)

**Table 2. Typical Calculation Categorization.<sup>1</sup>**

CALCULATION TYPE	ASSIGNED CATEGORY	NOTES
<b>General</b>		
Design Basis calculations	Formal	
Unit conversions done using Excel or other computational tool	Computational	
<b>Process Engineering Calculations</b>		
Process Flowsheet	Formal	
Material Balance	Informal	
Operational Data Review/Interpretation	Informal	
Process Equipment Sizing	Formal or informal	May be informal if performed at early stage of project for scoping purposes only. Formal for design basis or cost basis.
Timecycle Analysis	Informal or Formal	Depending on end use of results.
Airborne Emissions Estimates	Formal	
Flammable Gas calculations	Formal in support of SB	Informal for other types/data interpretation
Chemical Equilibrium modeling using ESP	Informal or Formal	Depending on end use of results. Highly dependent upon knowledgeable user.
Process stream physical and chemical properties	Formal for SB or design basis	Informal for other applications
Waste Compatibility Assessments	Formal	
Criticality	Formal	Mostly done by subcontractor
Interim Stabilization Record Volumes	Formal	
Chemical Addition Volume Calculations	Formal	
Calculations in, or supporting, Process Control Plans	Formal	Follow guidance in section 4.4.3

<sup>1</sup>This table should be used for guidance only. The specific discipline performing the type of calculation is not mandatory. The end-use and audience for the calculation must be considered in determining its final category. Any calculations categorized in this table that support Safety SSCs must be formal calculations. Categorization made per Table 1 (section 4.1) of this procedure.

**Table 2. Typical Calculation Categorization. (cont.)**

<b>CALCULATION TYPE</b>	<b>ASSIGNED CATEGORY</b>	<b>NOTES</b>
<b>Mechanical</b>		
Stress analysis, piping and components	Formal	
ASME Code Analyses	Formal	
Fluid flow, pressure drop, line sizing, control valve sizing	Formal	
Tool/custom equipment evaluation (e.g., water lance, pump removal)	Informal	
<b>Civil/Structural</b>		
Structural evaluation for temporary structures (e.g., tents, trailers)	Informal	
Dome load Analyses of Record and load evaluations for tanks and pits outside the dome load limits	Formal	Other dome load calculations are computational
Dome load calculations	Informal	Detailed, complex or multi-paged calculations
Dome load calculations	Computational	Simple dome load calculations—see definition of Computation
Structural analyses for tank riser loads, equipment supports on tanks and pits	Formal	
Structural analyses for piping, duct, and raceway supports, equipment racks, and panel supports	Formal	
Evaluations of hoisting and rigging for below-the-hook lifting devices	Formal (per ANSI B30.20)	
Structural analyses, general, including reinforced concrete, timber, steel structures	Formal (if using ANSYS, STAAD, or similar software)	Informal for other types unless mission critical or supports client/regulatory commitments
Analyses for DOT waste shipping containers	Formal	
Fall protection anchor points	Formal	Requires OSHA qualified person
Lift package calculations and evaluations of hoisting and rigging except below-the-hook	See notes	Decision by Engineering Discipline Lead - Civil/Structural, or designee on the type of

**Table 2. Typical Calculation Categorization. (cont.)**

<b>CALCULATION TYPE</b>	<b>ASSIGNED CATEGORY</b>	<b>NOTES</b>
lifting devices		calculation category is based on field conditions and existing lift point calculations.
<b>HVAC Calculations</b>		
Vent and balance calculations		Pre-set equations
Stack flows, aerosol tests	Computations	
<b>Electrical Calculations</b>		
Instrument Set Point Analysis	Formal (supporting safety SSC, assumptions or calculations of the safety basis)	Informal for other types
Lighting	Informal	
Heat trace sizing	Informal	Formal if supporting safety SSC
Electrical Load Study	Formal	Includes load, voltage, fault current/power, motor starting, and coordination of protective devices
<b>Nuclear Safety Calculations</b>		
Safety Basis calculations	Formal	Calculations that support FSAR/DSA/JCO
Calculations that are part of Technical Basis Documents	Formal	
Calculations to support Unreviewed Safety Question Evaluations	Formal	

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## ATTACHMENT A - CALCULATION FORMAT AND PREPARATION INSTRUCTIONS (FORMAL AND INFORMAL CALCULATIONS)

Include the following sections in the body of the calculation that are marked “required.” Other sections may be added as needed and the exact order of the sections is optional.

### 1. **Objective/Purpose** (required)

Describe the objectives (including the required end products) of the analysis including a problem statement. Describe the analysis performed in the calculation. Identify the calculation’s design requirements and applicable National Codes and Standards.

### 2. **Summary of Results and Conclusions** (optional depending on calculation length or complexity)

For lengthy or complex calculations, summarize the results and conclusions contained in later sections, highlighting the key points.

### 3. **Introduction/Background** (optional)

Provide any background information needed to understand the calculation purpose.

### 4. **Input Data** (required)

Information that serves as input to the calculation must be referenced to the source.

Information used to produce a hand calculation or used as input for a computer code must be explicitly stated, or be included in an attachment that will stay with the calculation. (It is not intended that impractical attachments, such as voluminous databases, be included.) Extensive compilations of input data used in more complex calculations may be better contained in separate appendixes.

Data files used in computer codes, with associated release numbers or dates, shall be listed. Enough information shall be included in the report to allow a complete reconstruction of all the input cases. This may include publishing all input files used to reach the conclusion(s) in the calculation.

Data and information used as input to the calculation shall be referenced to the source. Copies of reference information should be made available to the checker and organizational manager to simplify the review and approval process.

Information or data used to produce a hand calculation or used as input to a computer code or spreadsheet shall be included in an attachment. In the case of voluminous data from databases registered in Hanford Information System Inventory (HISI); reference can be made to the specific query, specific spreadsheet, date of query, column and range of data used in the calculation.

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## ATTACHMENT A - CALCULATION FORMAT AND PREPARATION INSTRUCTIONS (FORMAL AND INFORMAL CALCULATIONS) (cont.)

Where spreadsheets are used in support of calculation preparation, document the sources of the input data in this section and complete verification that input data is correctly entered in accordance with [TFC-ENG-DESIGN-C-32](#).

In documenting input data, preference should be given to providing the information in a numbered list format with a description of the type of input data used and the reference that it was taken from.

### 5. **Assumptions** (required if assumptions are made)

Explicitly state or reference assumptions used in the analysis along with supporting data or information. Assumptions that are stated must be used within the calculation. At a minimum:

- a. List key assumptions that must be verified prior to relying on the calculation for operation (e.g., those providing a basis for selection of Technical Safety Requirements and safety structures, systems, and components). Engineering HOLD or To Be Determined (TBD) notations for missing information must be controlled in accordance with [TFC-ENG-DESIGN-C-25](#).
- b. Clearly state assumptions resulting from engineering judgment with the basis for that judgment.

### 6. **Method of Analysis** (required)

The method needs to “stand alone” in quality and completeness so that a reasonably knowledgeable person would not have to seek the originator’s input on the methodology used in order to arrive at the same conclusions. Provide a brief description of the method of solution, numerical computations, and identification of the source or derivation of all equations that are not common usage. The method should use recognized national standards wherever possible with clear derivation of or reference to equations and any limitations on their use. Variables in equations need to be clearly defined.

If a formulation has been taken from an unpublished reference (such as an internal memo) or was developed by the engineer/analyst, the validity of the model or correlation must be demonstrated. The engineer/analyst must ensure that the uncertainties thus introduced will not impact the conclusions of the document. The actual numerical calculations may be included in this section where practical. Complex calculations or spreadsheets not readily contained within the body of the calculation are better contained in separate appendices.

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## **ATTACHMENT A - CALCULATION FORMAT AND PREPARATION INSTRUCTIONS (FORMAL AND INFORMAL CALCULATIONS) (cont.)**

Information necessary to reconstruct the analysis, including hand calculations, must be included.

Where repetitive use spreadsheets are used, their methodology should be documented in a published formal engineering calculation prepared in accordance with this procedure. Subsequent calculations performed with the repetitive use spreadsheet would then reference that calculation in this section for a full description of the method.

Where single use spreadsheets are used, their method should be described in this section or in a separate appendix.

### **7. Use of Computer Software** (required if software is used)

Documentation of computer codes shall include program name, version numbers, release dates, references to user manuals, and program verification data. If the calculation uses software that has previously been documented and verified in an engineering calculation, that calculation may be referenced. The new calculation must contain documentation that the previous verification is applicable.

If the calculation is performed by a spreadsheet (Excel), the spreadsheet shall be developed, documented, and verified in accordance with [TFC-ENG-DESIGN-C-32](#). The following information shall be included, as a minimum, in this section for each spreadsheet used in support of the calculation:

- Software and version used to create spreadsheet (e.g., Excel 2003)
- File name and version of spreadsheet
- Spreadsheet Verification and Release Form Number, providing evidence of verification
- Software name and version of any add-in software.

### **8. Results** (required)

Describe the results obtained. The number of significant figures reported shall be consistent with the quality of the data and with its purpose.

### **9. Conclusions** (required)

Describe the degree to which the objectives and purpose have been met along with information on the appropriateness and completeness of the results for the intended purpose.

### **10. Recommendations** (optional)

List the recommendation(s) including basis information.

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**ATTACHMENT A - CALCULATION FORMAT AND PREPARATION INSTRUCTIONS  
(FORMAL AND INFORMAL CALCULATIONS) (cont.)**

**11. References (required)**

Examples of references include drawings, reports, change notices, manuals, publications, codes, and standards. Provide the title, author (or company), and revision number or publication date, if available. References that may not be retrievable in the future, particularly informal communications that contain critical supporting information, shall be added to the document as attachments. The engineer/analyst must be able to supply the reviewer with a copy of any document cited in the analysis. If this calculation will support analyses that will be presented in the Tank Operations Contractor safety basis, a copy of all references cited shall be forwarded to the Safety Basis Library for future use.

**12. Attachments and Appendixes (optional)**

Include additional information such as computer software documentation (including spreadsheet printouts), calculation review checklist(s), spreadsheet verification form(s), detailed calculations not readily contained in the main body, extensive compilations of input data, inspection reports, and copies of references, memos, or pages of manuals.